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Original Research

Predicting patient visits at the psychiatric polyclinic of a public hospital in Bali, Indonesia: A forecasting approach using single exponential smoothing

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Abstract

Background: Hospital planning requires effective management of resources, facilities, and costs, and accurate patient visit forecasting is integral to this process. Forecasting methods, such as single exponential smoothing, are widely used to predict patient visits and aid in resource allocation. However, forecasting for psychiatric polyclinics presents unique challenges due to the fluctuating nature of mental health conditions and the difficulty in predicting patient behavior outside clinical settings.

Objective: This study aimed to apply the single exponential smoothing method to forecast psychiatric polyclinic visits at a public hospital in Bali province, Indonesia, for the years 2024–2026, with the goal of assisting hospital management in planning resources and services.

Methods: A retrospective analysis was conducted using patient visit data from January 2021 to December 2023. The data was processed and analyzed using the single exponential smoothing method through SPSS software. Forecasting accuracy was assessed using Root Mean Squared Error (RMSE) and Mean

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Absolute Percentage Error (MAPE), with forecasts for 2024–2026 generated for monthly patient visits.

Results: The forecast for psychiatric polyclinic visits predicted a steady increase in visits, with 9,320 visits in 2024, 9,627 visits in 2025, and 9,939 visits in 2026. The accuracy of the forecasting model was confirmed by a MAPE of 2.87%, indicating high precision. The RMSE value was 26.8%, suggesting the average forecasting error was 26.8%.

Conclusion: The single exponential smoothing method proved to be a reliable and straightforward tool for forecasting psychiatric polyclinic visits. With a high degree of forecasting accuracy, the method offers practical applications for hospital administrators to plan for future patient volume, optimize resource allocation, and ensure sufficient service capacity. Future research could explore the use of additional forecasting models and broader datasets to enhance predictive accuracy.

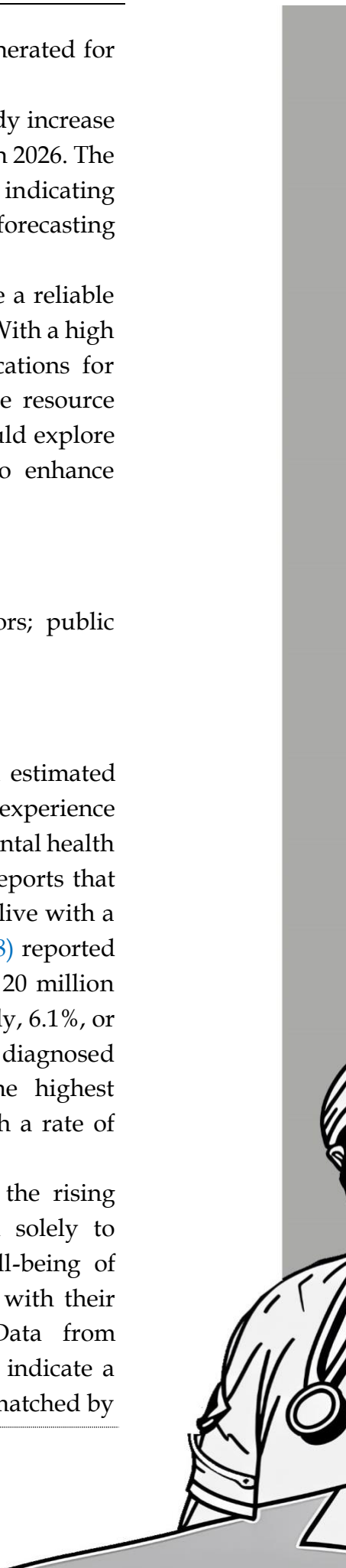
Keywords

Indonesia; mental health; hospital planning; hospital administrators; public hospitals; forecasting; resource allocation

Background

According to the to National Institute of Mental Health (2021), an estimated 22.8%, or approximately 57.8 million adults in the United States, experience mental health problems. It is estimated that one in five adults faces mental health issues each year. Similarly, the World Health Organization (2022) reports that one in every eight people globally, or about 970 million individuals, live with a mental disorder. In Indonesia, the Ministry of Health Indonesia (2018) reported that 9.8% of the population aged 15 years and older, or more than 20 million people, were affected by emotional and mental disorders. Additionally, 6.1%, or around 12 million individuals, suffer from depression, and 450,000 are diagnosed with schizophrenia or psychosis, a severe mental disorder. The highest prevalence of mental disorders was observed in Bali Province, with a rate of 11.1% per 1,000 households (Ministry of Health Indonesia, 2018).

Mental health conditions have become a global focus due to the rising prevalence of mental disorders. Mental health does not pertain solely to individuals with psychiatric conditions but also includes the well-being of mentally healthy individuals, emphasizing their ability to interact with their environment effectively (World Health Organization, 2022). Data from psychiatric polyclinics in public hospitals over the past three years indicate a significant increase in patient visits. However, this rise has not been matched by



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increased professional resources or logistical support, negatively impacting the quality of services provided. These challenges include long waiting times, inadequate waiting room facilities, insufficient medication supplies, and other necessary supporting resources (Aprilia, 2016).

Hospital planning is a critical component of hospital management, consisting of various aspects such as resource management, facility management, and cost management (Sombolinggi et al., 2024). Hospital planning is closely interrelated with forecasting the number of patients, as both are essential for effective health service management (Djakaria & Saleh, 2021). Accurate patient forecasting enables hospitals to devise appropriate strategies for enhancing service quality, including preparing necessary facilities and allocating resources to deliver optimal care. Health services can be provided effectively and efficiently through meticulous planning of healthcare workers and medication supplies. A key step in planning is conducting forecasts or predictions based on existing trends.

Effective forecasting serves as a crucial foundation for logistics and operations planning (Svetunkov et al., 2022). Such forecasts consider not only the number of patient visits but also the availability and capability of human resources and facilities, such as the availability of required medications and waiting room infrastructure, to ensure the delivery of optimal services. Forecasting systems often include automated model specification features, making the performance and reliability of model selection a vital factor (Safi & Sanusi, 2021).

Exponential smoothing is a forecasting method that uses weighted values from prior series observations to predict future values (Tratar et al., 2016). This method assigns the greatest weight to the most recent observations, with weights diminishing systematically as older observations are considered (Sharma et al., 2015; Shastri et al., 2018). The Exponential Smoothing Model is one of the most widely used forecasting techniques for time series data without clear trends or seasonal patterns (Shastri et al., 2018). Its flexibility, ease of use, and ability to produce reliable results make it accessible to managers without advanced statistical expertise (de Oliveira & Oliveira, 2018; Favorov et al., 2012). Exponential smoothing methods are valuable tools for denoising time series data, predicting future demand, and reducing inventory costs (Tratar et al., 2016).

This study proposes an intuitive, easy-to-implement, and computationally stable smoothing and forecasting method. Based on the considerations above, this study aims to forecast the number of psychiatric polyclinic patient visits at public hospitals over the next three years, from January 2024 to December 2026, using patient visit data from January 2021 to December 2023.

Methods

Study Design

This retrospective study utilized historical data of psychiatric polyclinic visits to develop and compare forecasting models for predicting future visits. The data was sourced from the hospital management system of a hospital located in Bali Province, Indonesia.

Samples and Data Collection

The study analyzed 26,016 visit records from January 2021 to December 2023, including patient details such as age, gender, date and time of arrival, and discharge information. During this period, the number of visits recorded was 8,390 in 2021, 8,615 in 2022, and 9,011 in 2023. This data served as the basis for forecasting visits for the next three years (January 2024 to December 2026) using the single exponential smoothing method.

Data Analysis

The single exponential smoothing method was used for forecasting visits. For time series analysis, statistical analyses were conducted using IBM SPSS Statistics version 22.0 (Asyhar et al., 2018). The model's accuracy was evaluated using RMSE and MAPE values. RMSE measures the root mean squared error of forecasts, while MAPE calculates the average percentage error over multiple periods. Forecasting is considered "very good" if the MAPE value is below 10% and "good" if it is below 20% % (Margi & Pendawa, 2015).

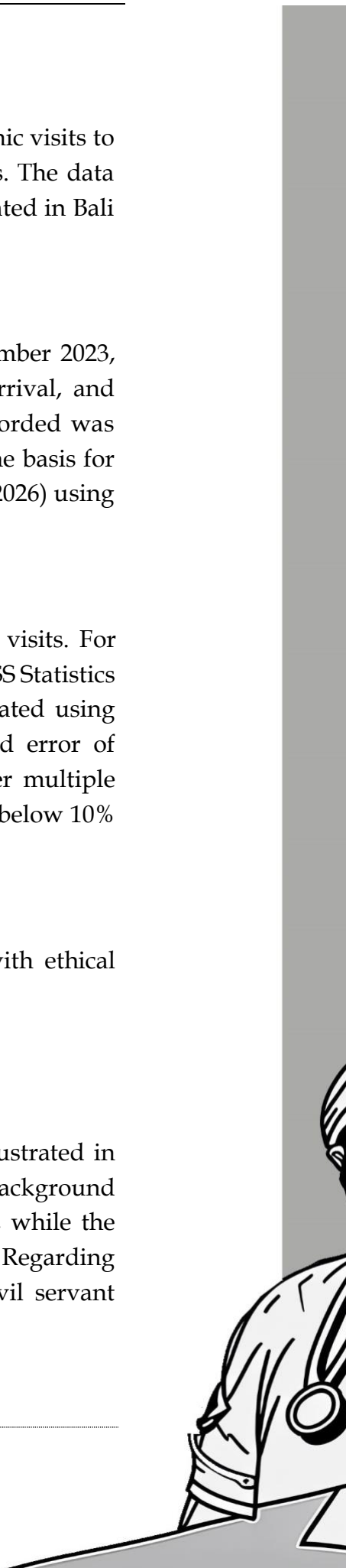
Ethical Considerations

The study permission has been secured from the study setting, with ethical clearance number: 076/EA/KEPK.RSBM.DISKES/2024.

Results

Characteristics of Psychiatric Polyclinic Employees

The characteristics of employees at the psychiatric polyclinic are illustrated in Figure 1 and Figure 2 . The distribution of employees by educational background reveals that the majority (82%, 14 employees) are Nurse graduates, while the remaining 18% (3 employees) have an Associate Degree in Nursing. Regarding employment status, most employees (71%, 12 individuals) hold civil servant positions, while 29% (5 individuals) are non-civil servants.



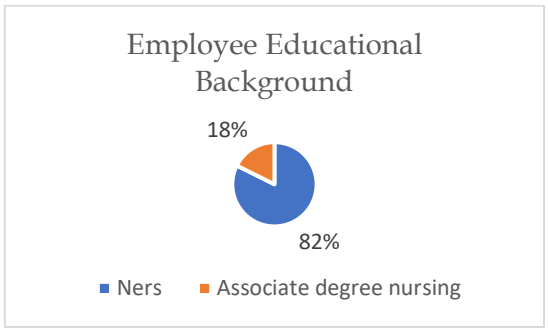


Figure 1 Distribution of the number of employees according to educational background at the psychiatric polyclinic

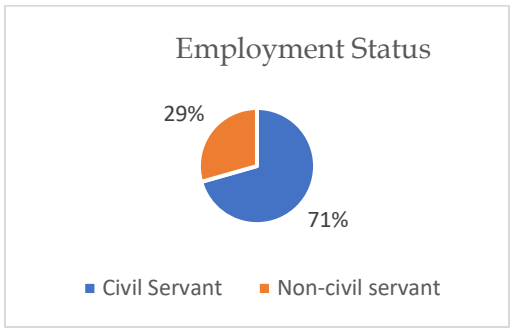


Figure 2 Distribution of employee status according to civil servant and non-civil servant status at the psychiatric polyclinic of a public hospital

Characteristics of Patient Visits to the Psychiatric Polyclinic

The characteristics of patient visits to the psychiatric polyclinic during the study period are shown in the figures below. Monthly patient visit data from January 2021 to December 2023 (Figure 3) have fluctuations; however, there is a general upward trend over time. Annual patient visits (Figure 4) show consistent growth, with a total of 8,390 visits recorded in 2021, 8,615 visits in 2022, and 9,011 visits in 2023, making 2023 the peak year during this period. Figure 5 highlights the distribution of patient visits based on administrative status. There is a significant increase in visits from patients covered by the National Health Insurance program (BPJS) compared to non-BPJS patients. Non-BPJS visits include patients recommended by Social Affairs or those who pay for services directly.

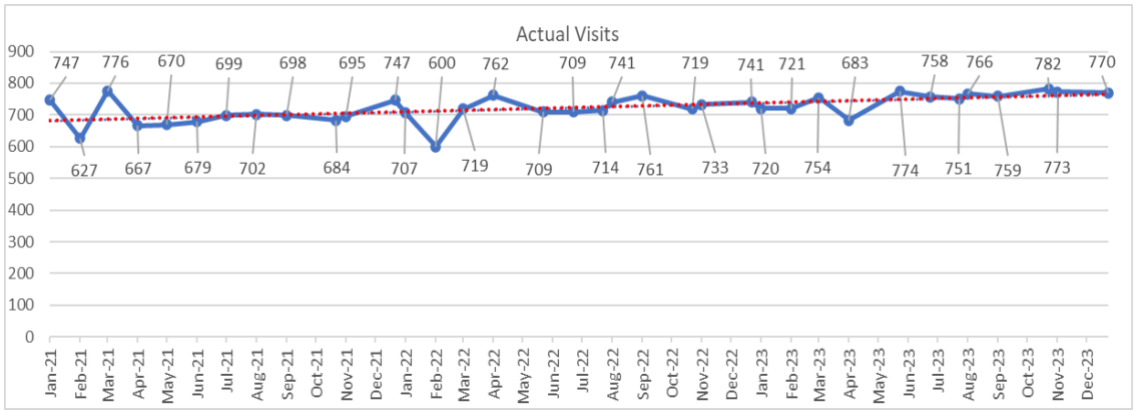


Figure 3 Graph of monthly patient visits at the psychiatric polyclinic from January 2021-December 2023

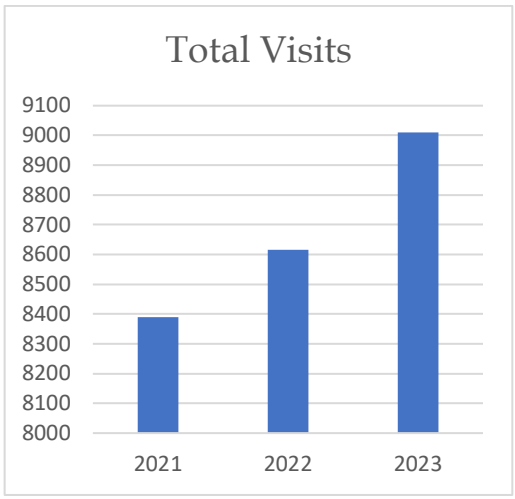


Figure 4 Graph of total visits per year of the psychiatric polyclinic for the 2021-2023 period

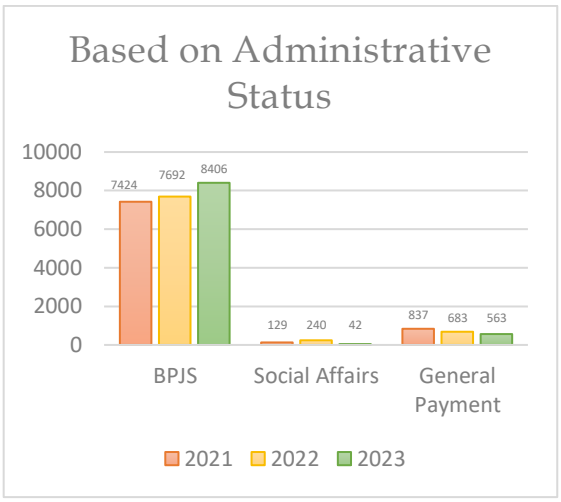


Figure 5 Graph of distribution of patient visits based on administrative status

Forecasts of total patient visits to the psychiatric polyclinic for the period 2024–2026 are shown in the following figures. Figure 6 compares actual visit data for 2021–2023 with forecasted data for 2024–2026. The red trendline indicates a steady annual increase in visits. Figure 7 shows the projected total outpatient visits for the psychiatric polyclinic, with predictions of 9,320 visits in 2024, 9,627 visits in 2025, and 9,939 visits in 2026, representing a consistent upward trend over the three-year forecast period.

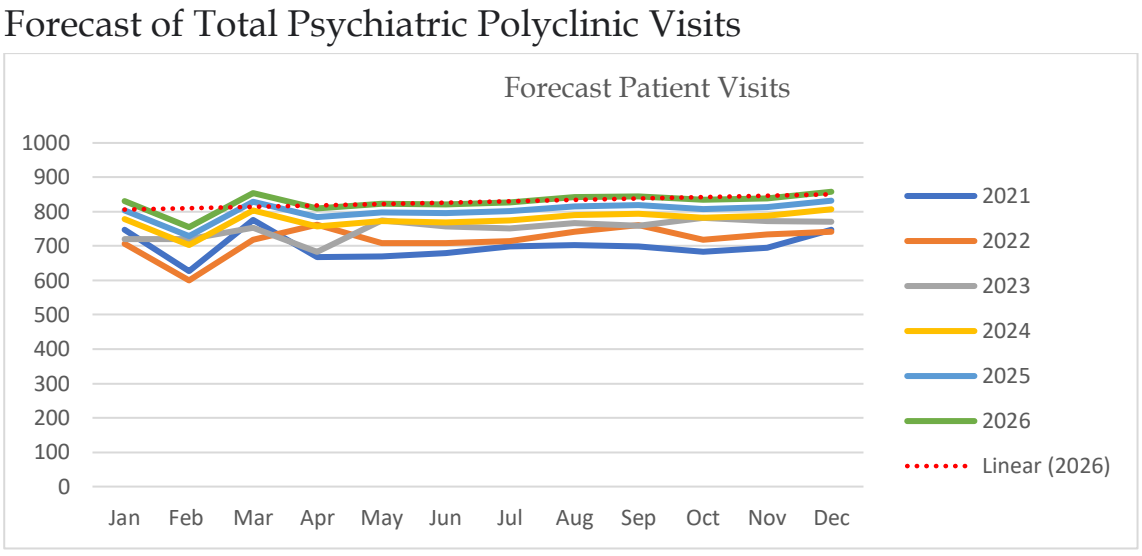


Figure 6 Graph of actual results and forecast using the single exponential smoothing method

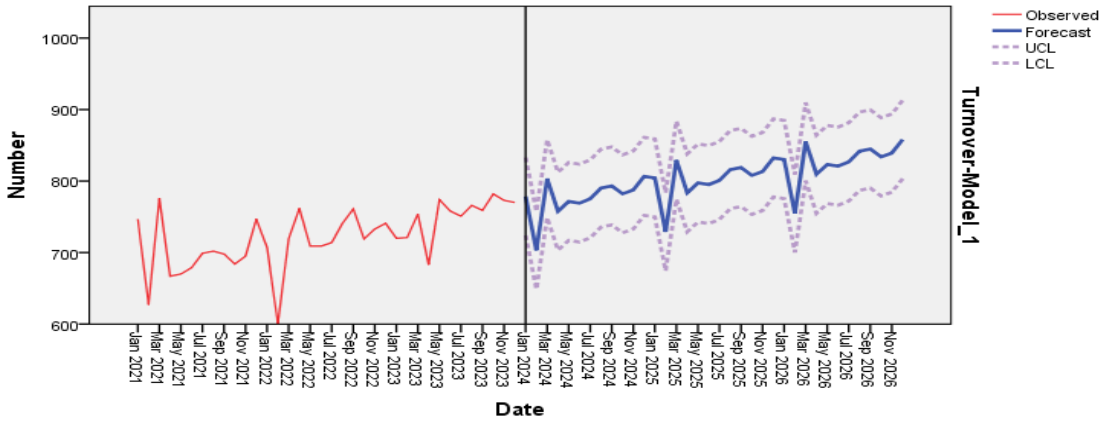


Figure 7 Graph comparing actual data and forecast data of total psychiatric polyclinic patient visits

Table 1 presents the monthly predictions for psychiatric polyclinic visits for 2024–2026. Visits are forecasted to range between 703 (February 2024) and 858 (December 2026). The confidence intervals (95%) for each predicted value provide a range for potential outcomes. For instance, visits in December 2024 are forecasted at 807, with a 95% confidence interval of 752–861.

Table 1 The predicted results of psychiatric polyclinic patient visits for January 2024-December 2026

Predicted Results of Psychiatric Polyclinic Patient Visits for January 2024-December 2026												
2024	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Predicted	779	703	804	758	772	769	775	790	793	782	788	807
95% UCL	833	758	858	812	826	824	830	845	848	837	842	861
95% LCL	724	649	749	703	717	715	721	736	739	728	733	752
2025	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Predicted	804	729	829	784	797	795	801	816	819	808	813	832
95% UCL	859	784	884	838	852	850	856	871	874	863	868	887
95% LCL	750	674	775	729	743	740	746	761	764	753	759	778
2026	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Predicted	830	755	855	810	823	821	827	842	845	834	839	858
95% UCL	885	810	910	864	878	876	882	897	900	889	894	913
95% LCL	776	700	801	755	769	766	772	787	790	779	784	803

Note: 95% UCL 95% upper confidence limit; 95% LCL 95% lower confidence limit

Table 2 Single Exponential Smoothing model fitting analysis output results

Model	**Stationary R-squared**	**R-squared**	**RMSE**	**MAPE**	**MAE**	**MaxAPE**	**MaxAE**	**Normalized BIC**
Turnover	0.822	0.626	26.764	2.866	20.560	8.761	56.252	6.873

Note: RMSE Root mean square error; MAPE Mean absolute percentage error; MAE Mean absolute error; MaxAPE Max absolute percentage error; MaxAE Max absolute error; BIC Bayesian Information Criterion

Table 3 Model statistics of Single Exponential Smoothing

Model	**Number of Predictors**	**Model Fit statistics**	**Ljung-Box Q(18)**			**Number of Outliers**
		Stationary R-squared	**Statistics**	**DF**	**Sig.**	
Turnover-Model_1	0	0.822	23.918	15	0.067	0

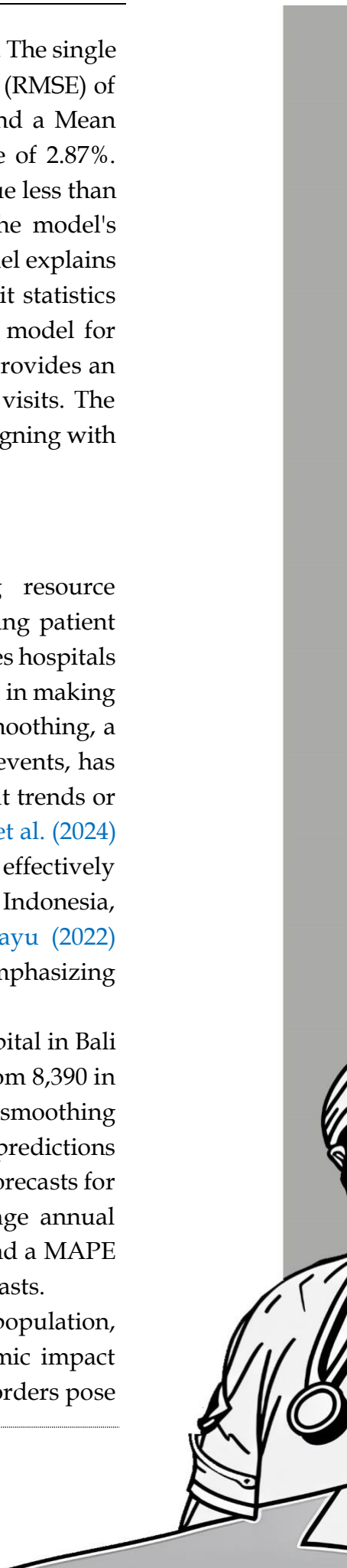
The performance of the forecasting model is summarized in Table 2. The single exponential smoothing method achieved a Root Mean Squared Error (RMSE) of 26.764, indicating an average squared forecasting error of 26.8%, and a Mean Absolute Percentage Error (MAPE) of 2.866, reflecting an error rate of 2.87%. These results demonstrate the model's high accuracy, as a MAPE value less than 10% indicates a very accurate forecast. Table 3 further confirms the model's robustness, with an R-squared value of 0.822, suggesting that the model explains 82.2% of the variation in the time series. Additionally, the model's fit statistics and Ljung-Box test results (p = 0.067) confirm the adequacy of the model for forecasting. In conclusion, the single exponential smoothing model provides an effective and reliable approach for predicting psychiatric polyclinic visits. The results indicate an average annual growth of 3–4% in patient visits, aligning with observed trends in the actual data.

Discussion

Hospital planning involves various critical aspects, including resource management, facility management, and cost management. Forecasting patient numbers is integral to effective health service management as it enables hospitals to manage resources more efficiently and aids hospital administrators in making informed decisions (Larabi-Marie-Sainte et al., 2022). Exponential smoothing, a time series forecasting method that uses past data to predict future events, has been shown to be effective for data with random fluctuations without trends or seasonality (Favorov et al., 2012). For instance, research by Rachman et al. (2024) demonstrated that the single exponential smoothing method effectively forecasted cataract patient visits at Undaan Eye Hospital Surabaya, Indonesia, which had fluctuations without discernible trends. Similarly, Rahayu (2022) highlighted the utility of this method in predicting malaria cases, emphasizing its adaptability and ease of application for health centers.

This study focused on psychiatric polyclinic visits at a general hospital in Bali province, Indonesia, where the number of visits increased steadily from 8,390 in 2021 to 8,615 in 2022 and 9,011 in 2023. Using the single exponential smoothing method, the forecast for 2024–2026 projects continued growth, with predictions of 9,320 visits in 2024, 9,627 in 2025, and 9,939 in 2026. Monthly visit forecasts for this period are detailed in the study's results, indicating an average annual increase of 3–4%. The model's accuracy yielded an RMSE of 26.8% and a MAPE of 2.87%. A MAPE below 10% confirms the high accuracy of the forecasts.

Globally, mental health disorders affect up to 1.5% of the population, representing a significant burden in terms of disability and economic impact (Barnett et al., 2018; World Health Organization, 2022). Psychotic disorders pose



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particular challenges, with relapse rates as high as 40% within a year of hospital discharge, even with proper antipsychotic treatment (Emsley et al., 2013). Relapses are associated with severe consequences, including self-harm, unemployment, strained relationships, and cognitive decline (Bergé et al., 2016). Forecasting patient visits remains challenging due to the complex nature of mental disorders and the difficulty in monitoring patient behaviors outside clinical settings.

The forecasted increase in psychiatric visits highlights the need for proactive measures by hospital management to address future demand. This includes enhancing healthcare infrastructure, fostering collaboration with mental health centers, and promoting annual awareness campaigns. Such initiatives will ensure that healthcare services are delivered efficiently and effectively, aligning with the anticipated growth in patient visits.

Implications

This study demonstrates the practical application of the single exponential smoothing method to estimate outpatient visits at psychiatric polyclinics. Given the global rise in mental health cases, this method provides a timely and reliable forecasting tool. Its simplicity and ease of interpretation make it particularly valuable for hospital administrators with limited statistical expertise. By offering reliable predictions, this method supports better resource allocation and decision-making in healthcare management.

Limitations

The study's main limitation lies in its reliance on three years of historical data (2021–2023). Although sufficient for initial forecasting, expanding longer time frames or additional variables, such as demographic data or regional health trends, could enhance accuracy. Furthermore, the focus on psychiatric visits limits the diversity of the dataset. Including data from other outpatient clinics or examining comorbid conditions could provide a more comprehensive understanding of resource requirements. Future research should explore alternative forecasting methods and models to validate and compare results across different healthcare settings. Expanding the scope beyond psychiatric visits to include a broader range of outpatient services would provide a more holistic view of hospital resource needs. Comparative studies across multiple hospitals could identify regional patterns and inform policy-making at both hospital and government levels.

Conclusion

The single exponential smoothing method effectively forecasted psychiatric polyclinic visits for 2024, achieving a MAPE of 2.87%, which is categorized as highly accurate. This method provides a fast and straightforward tool for predicting monthly visits, offering valuable insights for hospital planning. The forecasted increase in visits highlights the need for strategic planning to ensure adequate service facilities and infrastructure. These results emphasize the importance of integrating forecasting into healthcare management to meet rising demands and deliver quality care.

Declaration of Conflicting Interest
The authors have declared no conflict of interest.

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None.

Acknowledgment
None.

Authors' Contributions
NMRCD contributed data analysis, wrote the first draft of the manuscript, and revised the final draft. PC and NWS contributed to data acquisition. LGNSW contributed to the study's conception and design. All authors approved the final version of the article.

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Data Availability Statement
The supporting data analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of the Use of AI in Scientific Writing
There is nothing to declare.

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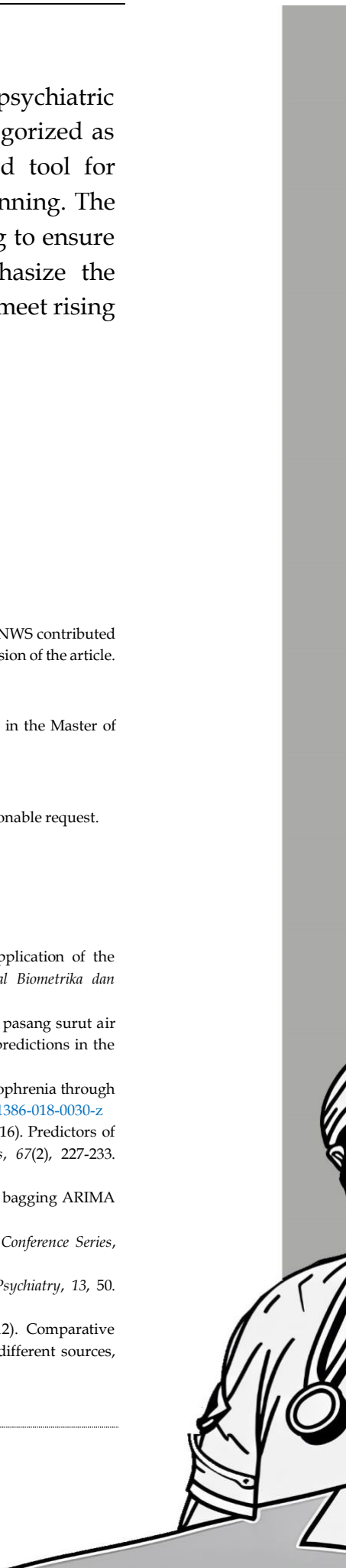

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